Interface Control Document Between Back End FOAD Module And Computing/Control Software

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1 DESCRIPTION

1.1 PURPOSE

The purpose of this document is to define the Monitor and Control interface between the supervisory microprocessor in the FOAD module and the Computing Monitor and Control software.

1.2 SCOPE

The document contains lists of monitor and control points available in the controller and their suggested access rates. It also contains instructions on how to use these points to access the serial port of the EDFA.

2 RELATED DOCUMENTS AND DRAWINGS

2.1 APPLICABLE DOCUMENTS

[AD 01] ALMA-75.35.00.00-002-A-STD (ex. ALMA-US Computing Memo #7) ALMA Monitor and Control Bus Interface Specifications, Version C, 2001-September-07.

[AD 02] ALMA Software Glossary, Draft Version, 2003-05-21

[AD 03] ALMA-75.35.00.00-001-A-STD (ex. ALMA08002.0006) Generic Monitor and Control Points, Draft, 2000-November-01

[AD 04] ALMA-70.35.10.02-001-A-MAN - ALMA Computing memo #12, “ALMA Monitor & Control Bus, AMBSI2 Standard Interface, Design Description”, 2001-May-03

[AD 05] ALMA FOAD Module Hardware Description – BEND-54.05.00.00-001-DWG

[AD 06] ALMA FOAD Module Block Diagram – BEND-54-05-00-00-003-A-DWG

2.2 ABBREVIATIONS AND ACRONYMS

ADC	Analog – digital converter
AMB	ALMA monitor and control bus
AMBSI	AMB standard interface
CAN	Controller Area Network
DWDM	Dense wave division multiplexer
EDFA	Erbium-doped fiber amplifier
SPI	Serial peripheral interface

See also [AD 02].

3 PHYSICAL SYSTEM INTERFACES

3.1 MECHANICAL INTERFACE

Four FOAD modules will occupy one 6-unit-high bin. Each module plugs into a 3-unit-high backplane in the lower half of the bin. Two AMBSI boards are mounted on the backplane. The backplane also carries a 48 V to 5 V DC-DC converter which supplies power to the two AMBSI2s and to the microcontrollers in the four modules. A 16-way switch on the backplane is used to set the bin number. Two DB9 connectors (one male, one female) for the CAN trunk connections are mounted on the crate.

3.2 ELECTRICAL POWER INTERFACE

The modules are powered by the 48 V rack supply.

3.3 ELECTRONIC INTERFACE

Two AMBSI2 boards as described in [AD 04] will be used to connect to four modules. Each AMBSI2 connects to two modules: one via the primary SPI port, the other by the secondary SPI port. The bin number (set by a switch) and the location in the bin determine the node address for each AMBSI2 (see 4.1.3).

3.3.1 LIST OF CONNECTORS

Type	***Reference***	***Function***
DB-9 male	*TBD*	*CAN trunk in*
DB-9 female	*TBD*	*CAN trunk out*
Phoenix 2.5/2-G-5.08	*TBD*	*48 volt power supply*

3.3.2 INTERCONNECTION DATA

See [AD 05].

4 SOFTWARE/CONTROL FUNCTION INTERFACE

4.1 OVERVIEW

Each module contains an erbium doped fiber amplifier (EDFA), a dense wave division multiplexer (DWDM), and a controller circuit board. Four of these modules plug into a backplane that carries two AMBSI2 modules, each supervising two modules: power supplies and CAN bus connectors.

The DWDM is an entirely passive device that requires no supervision. The EDFA is a more complicated device, supervised by a microcontroller (PIC16F877A) that communicates, via a SPI interface and one of the AMBSIs, with the AMB.

There are three ways of communicating with the EDFA:

- Simple commands can be sent to, and status received from, direct I/O pins on the EDFA.
- More complex commands are sent to and received from an RS232 protocol serial port. Because of the great disparity between the speed of the SPI interface (4MHz) and of the serial link (9.6KHz), the commands and replies are buffered in the PIC.
- Finally, several analog measurements are digitized in the PIC and made available to the AMB.

The controller communicates monitor and control data to an AMBSI2 located on the backplane using a Serial Peripheral Interface (SPI). The interface will be configured to work with a variable size monitor data length in an address space of 256 bytes. In practice only about 20 points are meaningful and of these only three may be written to.

The microprocessor can be reset by power-cycling the module or by the signal RESET* from the AMBSI. This signal will become active in response to the AMB accessing the monitor point at relative CAN address 0x31001.

The EDFA is controlled and monitored by a PIC 16F877 microcontroller that is interfaced to the ALMA Monitor and Control Bus. The microcontroller measures power-supply voltage and current, input and output optical power levels, and heat sink temperature through its internal 10-bit analogue-digital converter (ADC). It also monitors the digital fault lines from the EDFA. It can turn the DC supply to the EDFA on and off and can disable or mute the EDFA optical output.

The microcontroller is powered by a 5 V supply obtained from a DC-DC converter on the backplane. This converter also powers the AMBSIs. The status of the system can be monitored and controlled via the AMB.

The controller will enter normal operation mode within one second of the application of DC power. The EDFA power supply will be off and can only be turned on by the AMB issuing a command. After applying power there is an initialization period of about three seconds during which EDFA-derived faults are not monitored.

Operator notification is required if the status bytes report a fault; i.e. if an analog measurement is outside the normal operating limits (specified as part of the relevant monitor points). If a power supply or temperature measurement reaches a value that could cause component damage, the power supply will be shut down. These limits are outside the normal operating limits specified in this ICD. The most common malfunction probably will be a low or zero reading of optical input power, which might indicate a broken or disconnected fiber.

If an analog measurement reaches a value that could cause component damage, the EDFA power supply will be shut down. These limits are outside the normal operating limits specified in this ICD.

A graceful shutdown of the EDFA is done by issuing the appropriate command, but no damage will be caused by removing the 48 V power line. The module must not be removed when power is applied to the EDFA.

4.1.1 MAINTENANCE MODE

The module can, if a certain pin on the PCB is grounded as the device is powered on, be put into a maintenance mode. In this mode the monitor and control interface described in this document is extended and includes a number of commands that are only useful when the module is on the bench. Some of these commands allow limits to be overridden and hence may, if not used carefully, allow the hardware to be damaged. These points are described in [AD 05].

Normal operation can occur while in maintenance mode, but because it is possible to inadvertently damage the hardware, the control software must shut down the power supplies and notify the operator if normal operations are to commence using a module that is operating in maintenance mode. The *GET_STATUS_P* monitor point indicates when the module is in maintenance mode.

4.1.2 VALIDITY OF READINGS

Many of the monitor points return values that are the result of ten-bit analog-to-digital conversions. At the end of the conversion cycle two bytes are moved from the ADC registers to the monitor points. If a monitor transfer, which is serviced under interrupt, happened between the two transfers, each byte read would be from a different conversion cycle.

To mitigate this, the top bit of the MS byte is set to one before the move, the move is done LS byte first, and the bit is cleared at the end of the move. If a transfer is interrupted, the returned monitor point will have the top bit set. As these monitor points are all (int16), this would be interpreted as a large negative number. Such an invalid reading is transient and the monitor point should be retried immediately. The probability of an invalid reading is estimated at 1 in 10,000 for each point.

All points that can return an invalid reading are indicated in the description.

4.1.3 NODE NUMBERS

The 64 modules require the 32 nodes from 0x280 to 0x29F. Assuming that the switch on the backplane is set to position S (where S can take values from 0 to 15) and numbering the four units from 0 on the left to 3 on the right:

Units 0 and 1 are serviced by a single AMBSI at node number = 0x280 + 2 * S

Units 2 and 3 are serviced by a single AMBSI at node number = 0x281 + 2 * S

Units 0 and 2 are connected to the AMBSI as device one and have RCAs ranging from 0x0001 to 0x000FF.

Units 1 and 3 are connected to the AMBSI as device two and have RCAs ranging from 0x18000 to 0x180FF.

The RCAs listed below refer to device one and should be increased by 0x18000 for device two.

4.1.4 INVALID ADDRESSES

If a monitor request is made from a RCA which is not listed in section 4.2 there will be no response from the module.

If a control access is made to a point which is not listed in section 4.3 the accompanying data will be accepted but no further action will occur. If the length of a control access is greater than that specified in section 4.3 all the bytes will be accepted but only the appropriate number will be used, starting with the first byte received.

4.2 SUMMARY OF MONITOR POINTS

Monitor data shall be polled by the ALMA bus master according to the protocol specified in [AD 01].

NAME	RELATIVE CAN ADDRESS	DATA SIZE (BYTES)	SUGGESTED INTERVAL (SECS)	TIMING EVENT RELATED?
GET_STATUS_P	0x0 00 20	2	1	No
GET_STATUS_E	0x0 00 22	2	1	No
GET_OPIN_ POW	0x0 00 24	2	10	No
GET_OPOUT_ POW	0x0 00 26	2	10	No
GET_PSU_ VOLT	0x0 00 28	2	10	No
GET_PSU_ AMP	0x0 00 2A	2	10	No
GET_HS_ TEMP	0x0 00 2C	2	10	No
GET_VN	0x0 00 2E	2	Startup	No
GET_XOVERA	0x0 00 30	2	10	No
GET_DIGITAL_FLT	0x0 00 32	2	After Fault	No
GET_OPIN_FLT	0x0 00 34	2	After Fault	No
GET_OPOUT_FLT	0x0 00 36	2	After Fault	No
GET_VOLT_ FLT	0x0 00 38	2	After Fault	No
GET_AMP_ FLT	0x0 00 3A	2	After Fault	No
GET_TEMP_FLT	0x0 00 3C	2	After Fault	No
GET_XOVERB	0x0 00 3E	2	10	No
GET_LRU	0x0 00 40	8	Startup	No
GET_S DATA	0x0 00 80	8	See section 5	No

The relative CAN addresses are for the first device at the node. For the second device the addresses should be increased by 0x18000.

4.3 SUMMARY OF CONTROL POINTS

Control data shall be transmitted by the ALMA bus master according to the protocol specified in [AD 01].

NAME	RELATIVE CAN ADDRESS	DATA SIZE (BYTES)	SUGGESTED INTERVAL (SECS)	TIMING EVENT RELATED?
SEND_SDATA	0x0 00 80	1-8	See section 5	No
RESET_SDATA	0x0 00 C0	1	See section 5	No
SET_EDFA	0x0 00 C1	1	As needed	No

The relative CAN addresses are for the first device at the node. For the second device the addresses should be increased by 0x18000.

4.4 MONITOR POINTS IN DETAIL

4.4.1 GET_STATUS_P

RCA	0x0 00 20 (0x1 80 20)			
Description	Primary Status Word			
Suggested Interval	1 sec.			
TE Related	No			
Data ubyte[2]	ubyte[0]: Status			
	Bits 0-2	If bit 7 is set these give the reason for the PSU shutdown		
		0x0	No attempt has been made to start the PSU	
		0x1	EDFA status fault	#1
		0x2	Input power out of limits	#1
		0x3	Output power out of limits	#1
		0x4	PSU voltage out of limits	
		0x5	PSU current out of limits	
		0x6	Heat sink temp out of limits	
		0x7	Shut down by M&C command	
	Bit 3		Unused (undefined)	
	Bit 4		Unused (undefined)	
	Bit 5		The board is in maintenance mode	
	Bits 6-7	0x0	The EDFA PSU is on and the EDFA in normal operation	
		0x1	The EDFA PSU is on and the EDFA is initializing	
		0x2	The EDFA PSU is shut down	
		0x3	The EDFA PSU is shut down	
	Ubyte[1]: Secondary Status			
	Bits 0-2	Reason for last restart		
		0x0	MCLR/ - a reset from the SPI	
		0x1	Power Up - reset	
		0x2	Brown Out - reset caused by a voltage dip	#2
		0x3	Watch Dog Time Out - reset	#3
	Bit 3		Unused (undefined)	
	Bits 4-6	Status of serial port transfer buffer		
		0x0	The buffer is ready to receive data from the SPI	
		0x1	Data is being sent from the buffer to the EDFA	
		0x2	Waiting for reply from the EDFA	
		0x3	Data is being received by the buffer from EDFA	
		0x4	There is a complete message in the buffer	
		0x5	Timed out waiting for data	
		0x6	A data overrun occurred while receiving EDFA data	
		0x7	A framing error occurred while receiving EDFA data	
	Bit 7		Unused (undefined)	
Notes	1. These faults are not monitored while the EDFA is initializing. 2. A brown out occurs if the PIC supply voltage falls below 4volts for a period exceeding 100uS. 3. A watch dog time out implies a firmware fault.			

4.4.2 GET_STATUS_E

RCA	0x0 00 22 (0x1 80 22)	
Description	EDFA digital alarms	
Suggested Interval	1 Sec	
TE Related	No	
Data ubyte[2]	ubyte[0]: EDFA alarm indications	
	Bit 0	Loss of Input Power
	Bit 1	Pump Temperature Alarm
	Bit 2	Pump Bias Alarm
	Bit 3	Loss of Output Power
	Bit 4	EDFA Temperature Alarm
	Bits 7-5	Unused (undefined)
	ubyte[1] EDFA power status	
	Bit 0	When hi the EDFA output is muted to +7dBm When lo the EDFA output is set normal
	Bit 1	When hi the EDFA output is disabled When lo the EDFA output is enabled
	Bits 2-7	Unused (undefined)
Notes	Alarm bits 1 and 4 will cause a power supply shutdown (See 4.4.1 and 4.4.10). Alarm bit 2 urgently requires operator intervention. The alarms and controls are explained in detail in the EDFA manual (see appendix 1).	

4.4.3 GET _OPIN_ POW

RCA	0x0 00 24 (0x1 80 24)
Description	Measured optical input power level to the EDFA. Values are produced using a 10-bit analog-to-digital converter; therefore, valid readings will always be between 0 and 1023. An invalid result can be returned (see *Validity of Readings*).
Suggested Interval	10 seconds
TE Related	No
Data int16	Power = (Value/1024) * (2.43/2.40)W The reading should also be available in decibels (reference level 1mW = 0dB)
Operating Range	TBD

4.4.4 GET _OPOUT_POWER

RCA	0x0 00 26 (0x1 80 26)
Description	Measured optical output power level from the EDFA. Values are produced using a 10-bit analog to digital converter; therefore, valid readings will always be between 0 and 1023. An invalid result can be returned (see *Validity of Readings*). This reading is not meaningful when the EDFA PSU is shut down.
Suggested Interval	Same as *GET _OPIN_ POW*
TE Related	
Data int16	Power = (Value/1024) * (2.43/99.6) * 1000 mW The reading should also be available in decibels (reference level 1mW = 0dB).
Operating Range	TBD

4.4.5 GET _PSU_VOLT

RCA	0x0 00 28 (0x1 80 28)
Description	Measured value of the EDFA supply voltage. Values are produced using a 10-bit analog-to-digital converter; therefore valid readings will always be between 0 and 1023. An invalid result can be returned (see Validity of Readings). This reading is not meaningful when the EDFA PSU is shut down.
Suggested Interval	Same as *GET _OPIN_ POW*
TE Related	
Data int16	Voltage = (Value /1024) * (2.43/0.4) V
Operating Range	4.75 to 5.25 V

4.4.6 GET _PSU_AMP

RCA	0x0 00 2A (0x1 80 2A)
Description	Measured value of the EDFA supply current. Values are produced using a 10-bit analog-to-digital converter; therefore valid readings will always be between 0 and 1023. An invalid result can be returned (see Validity of Readings). This reading is not meaningful when the EDFA PSU is shut down.
Suggested Interval	Same as *GET _OPIN_ POW*
TE Related	
Data int16	Current = (Value /1024) * (2.43/0.5)
Operating Range	0 to 5 Amps

4.4.7 GET _HS_TEMP

RCA	0x0 00 2C (0x1 80 2C)
Description	Measured value of heat sink temperature. Values are produced using a 10-bit analog to digital converter; therefore valid readings will always be between 0 and 1023. An invalid result can be returned (see Validity of Readings).
Suggested Interval	Same as *GET _OPIN_ POW*
TE Related	
Data int16	Temperature = (Value/1024) * (2.43/10) * 1000 °C
Operating Range	5 to 60 °C

4.4.8 GET _VN

RCA	0x0 00 2E (0x1 80 2E)	
Description	Version number of firmware.	
Suggested Interval	At startup	
TE Related	No	
Data uint8[2]	uint8[0]	Major revision level
	uint8[1]	Minor revision level and patch level
Note	0xAB,0xCD is interpreted as Ver AB.C.D	

4.4.9 GET _XOVERA

RCA	0x0 00 30 (0x1 80 30)
Description	The first crossover point for the pump.
Suggested Interval	10 seconds
TE Related	No
Data Int16	Software should report whether this value is positive, negative or zero.

4.4.10 GET _DIGITAL _FLT

RCA	0x0 00 32 (0x1 80 32)
Description	Value of digital indicators immediately prior to a power supply shutdown. In the case of digital fault this monitor point contains the reading which precipitated the shutdown. Only meaningful if primary status word bit 6 is set.
Suggested Interval	After a fault
TE Related	No
Data ubyte[2]	ubyte[1]: Digital fault indications Same as *GET_STATUS_E* byte[1]
	ubyte[0] : Unused (undefined)

4.4.11 GET _OPIN_ FLT

RCA	0x0 00 34 (0x1 80 34)
Description	Voltage of optical input power immediately prior to a power supply shutdown. If the input is at fault, this monitor point contains the reading which precipitated the shutdown. Only meaningful if primary status word bit 6 is set.
Suggested Interval	After a fault
TE Related	No
Data int16	Same as *GET _OPIN_ POW*
Operating Range	

4.4.12 GET _OPOUT_ FLT

RCA	0x0 00 36 (0x1 80 36)
Description	Voltage of optical output power immediately prior to a power supply shutdown. If the output is at fault, this monitor point contains the reading which precipitated the shutdown. Only meaningful if primary status word bit 6 is set.
Suggested Interval	After a fault
TE Related	No
Data int16	Same as GET *_OPOUT_POWER*
Operating Range	

4.4.13 GET _VOLT_ FLT

RCA	0x0 00 38 (0x1 80 38)
Description	Voltage of EDFA power supply voltage immediately prior to a power supply shutdown. If the voltage is at fault, this monitor point contains the reading which precipitated the shutdown. Only meaningful if primary status word bit 6 is set.
Suggested Interval	After a fault
TE Related	No
Data int16	Same as *GET _PSU_VOLT*
Operating Range	

4.4.14 GET _AMP_ FLT

RCA	0x0 00 3A (0x1 80 3A)
Description	Current from EDFA power supply voltage immediately prior to a power supply shutdown. If the current is at fault, this monitor point contains the reading which precipitated the shutdown. Only meaningful if primary status word bit 6 is set.
Suggested Interval	After a fault
TE Related	No
Data int16	Same as *GET _PSU_AMP*
Operating Range	

4.4.15 GET _TEMP_ FLT

RCA	0x0 00 3C (0x1 80 3C)
Description	Heat sink temperature immediately prior to a power supply shutdown. If the temperature is at fault, this monitor point contains the reading which precipitated the shutdown. Only meaningful if primary status word bit 6 is set.
Suggested Interval	After a fault
TE Related	No
Data int16	Same as *GET _HS_TEMP*
Operating Range	

4.4.16 GET _XOVERB

RCA	0x0 00 3E (0x1 80 3E)
Description	The second crossover point for the pump.
Suggested Interval	Same as *GET _XOVERA*
TE Related	
Data int16	

4.4.17 GET _LRU

RCA		0x0 00 40 (0x1 80 40)	
Description		CIN, Serial Number and Revision Level	
Suggested Interval		At startup	
TE Related		No	
Data	**int8[4]** **int16** **int8[2]**	int8[0]	1st level of CIN – always 54
		int8[1]	2nd level of CIN – always 05
		int8[2]	3rd level of CIN – always 02
		int8[3]	4th level of CIN – always 00
		Int16	Unit serial number
		ubyte[4]	Unit revision level (1=revA .26=revZ)
		ubyte[5]	Unused – always zero
Note		A revision level of 0xFF means that the non-volatile memory in which serial number and revision level are stored has not been programmed or is faulty. A revision level of 0x00 means that this is a prototype board which should not be in use on the array.	

4.4.18 GET_SDATA

RCA	0x0 00 80 (0x1 80 80)
Description	Read eight bytes from the serial port data buffer starting at the current value of the buffer pointer. The buffer pointer is then advanced by eight at the end of the transfer. Multiple reads from this point may be needed to acquire a complete null terminated string from the EDFA serial port. (See Section 5, The Serial Port)
Suggested Interval	Debug
TE Related	No
Data ubyte[8]	Each byte is an ASCII character
Note	Reading from the buffer is only permitted when GET_STATUS_S shows that there is a complete message in the buffer. Reading at other times will return a length of zero (DMC byte = 0x0F) and no data will be transferred.

4.5 CONTROL POINTS IN DETAIL

4.5.1 SEND _SDATA

RCA	0x0 00 80 (0x1 80 80)
Description	Write up to eight bytes to the serial port data buffer starting at the current value of the buffer pointer. The buffer pointer is advanced by one after each byte. Multiple writes may be needed to send a complete null terminated string to the EDFA serial port (SeeThe Serial Port)
Suggested Interval	Debug
TE Related	No
Data ubyte[n]	1 <= n <= 8 Each byte is an ASCII character.
Note	Writing to the buffer is only permitted when GET_STATUS_S shows that the buffer is ready to accept data. Writing at other times is equivalent to writing to an unlisted RCA; the buffer is unchanged.

4.5.2 RESET_SDATA

RCA	0x0 00 C0 (0x1 80 C0)
Description	Set the serial port buffer point to zero and set the serial port status to ready.
Suggested Interval	As required
TE Related	No
Data Int8	Dummy value
Note	If the length written to this control point is greater than one, the command will execute and the extra bytes will be thrown away.

4.5.3 SET_EDFA

RCA	0x0 00 C1 (0x1 80 C1)		
Description	Set the EDFA output power		
Suggested Interval	As required		
TE Related	No		
Data ubyte[1]	Bits 0-1	0x0	Turn the EDFA power off
		0x1	Turn the EDFA power on and disable the output
		0x2	Turn the EDFA power on and mute the output to +7dBm
		0x3	Turn the EDFA power on with output a full power
	Bits 2-7		Ignored
Notes	The success of writing to this control point can be verified by reading from *GET_STATUS_P* & *GET_STATUS_E*		
	If the length written to this control point is greater than one, the command will execute using data from the first byte received and the extra bytes will be thrown away.		

5 THE SERIAL PORT

5.1 PROTOCOL

Communication with the serial port of the EDFA is achieved by sending a text string to which the EDFA replies with another text string. This is intended for connection to a serial port on a computer and operates at the low speed of 9600 baud. In order to interface to the much faster SPI a 64 byte data buffer is used. An internal register, the buffer pointer, is used to address the data buffer.

To send a command to the port:

- Ensure that the buffer is ready by reading the top nibble of GET_STATUS_S.
- Reset the address pointer by issuing the appropriate command. (RESET_SDATA)
- Send the string to SET_SDATA. This auto-increments the buffer pointer. Terminate the string by sending a null character (character 0).
- Wait until GET_STATUS_S shows that the reply from the EDFA is complete or that the transfer has timed out or failed. The buffer pointer will be set back to zero at the end of a successful transfer.
- Read the null-terminated string from GET_SDATA; the buffer pointer auto-increments.
- Reset GET_STATUS_S and the address pointer by sending the appropriate command.

The EDFA takes up to two seconds to reply. If a reply is not received within about three seconds, GET_STATUS_S will show a timeout. This could be caused by a faulty or unpowered EDFA, an incorrectly terminated command, or by improperly established communications. After power is applied to the EDFA, the make active command string must be sent to establish communications. Note that it is essential to use the quiet version of the command (“ADQ 1”) rather than the standard version (“AD 1”)

The buffer for transmission is 64 bytes and wraps around. The buffer for reception is 128 bytes and also wraps around.

5.2 EDFA COMMANDS

The command structure is detailed in the EDFA user manual section (Appendix 1). Most of the commands are only used for setting up the EDFA. While this would generally be done on the bench, it might occasionally be necessary to make adjustments in the field so the serial port cannot be confined to the maintenance mode.

If the EDFA pump bias alarm (see 4.4.2) is active, this indicates that the EDFA is reaching the end of its service life and the operator should be notified.

It would be useful to perform the Version Inquiry command at startup and make this information available.

6 SAFETY INTERFACE

There are no laser safety issues; opening the module is not possible without removing it from the rack. Doing so disconnects the power supply and renders the unit safe.

The module should not be removed from the rack while power is applied to the EDFA.

In maintenance mode it is possible to change or override safety mechanisms, which could lead to faulty operation or equipment damage. It should not be possible for the board to be in this mode when it is installed on the antenna but if due to a gross fault the board is found at startup to be in maintenance mode the EDFA power **must not be applied** and the operator must be notified.

It is important that no two bins are set to the same number. This will not cause any damage but will cause the CAN bus to ignore one of the two bins.

7 APPENDIX 1

On following pages.

Table 8: Connector Pin - Out
The pinout for the male DB25 connector

PIN #	Function	PIN #	Function
1	+5.0V	14	GND
2	+5.0V	15	GND
3	+5.0V	16	GND
4	+5.0V	17	GND
5	Output Power Monitor	18	RS-232 OUT (TTL Levels)
6	Input Power Monitor	19	Loss of Input Power Alarm
7	EDFA Temperature Alarm	20	Output Power Mute Input
8	Loss of Output Power Alarm	21	Amplifier Disable Input
9	Pumps Bias Alarm	22	RS-232 IN (TTL Levels)
10	Pumps Temperature Alarm	23	N/C
11	N/C	24	+5.0V
12	+5.0V	25	GND
13	GND	-	-

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NORTEL NETWORKS™

MGM
MultiWavelength Gain Module

Configuration Manual

NORTEL NETWORKS™

MGM EDFA
Instruction Manual

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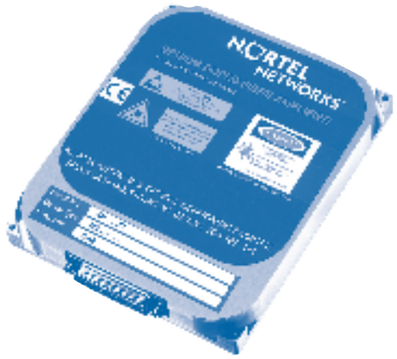

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NORTEL NETWORKS™

Introduction

This document provides the user with information relating to the use of the Nortel Networks' MultiWavelength Gain EDFA Module. Details on how to configure the unit via the serial port, electrical connections, digital control lines and power requirements are included. For detailed optical and electrical characteristics, please refer to the appropriate data sheet.

Optical Safety

The MGM amplifier is rated according to the following classification:

Class 3B laser product in accordance with IEC825-1:1993

Class IIIb laser product in accordance with 21CFR 1040.10

Care must be taken to avoid exposure.

Description

MGM amplifier modules may be specified for use in 1530-1563nm (C-Band) and 1570- 1603nm (L-Band) DWDM optical transmission systems. The module is designed for integration with a control system, which will include appropriate power supplies, serial communications, alarm monitoring and thermal control. The integral control system monitors input and/or output optical powers and the status of the components within the optical amplifier module. This information is used to adjust the control parameters to maintain the required amplifier performance. Analogue and digital electrical connections allow external control of the module, continuous monitoring of its performance, and provide TTL logic levels associated with specified faults for system performance alarms.

Electrical Connections

All electrical connectivity is achieved through the 25 way D-type plug connector. Power supply requirement is a single 5 V supply to 6 pins as defined in Table 1.

Table 1: Electrical Pin Connections

Pin Number	Description
1, 2, 3, 4, 12, 24	+5.0V
13, 14, 15, 16, 17, 25	GND
5	Output Power Monitor
6	Input Power Monitor
7	EDFA Temperature Alarm
8	Loss of Output Power Alarm
9	Pumps Bias Alarm
10	Pumps Temperature Alarm
11, 23	N/C
18	RS-232 OUT (TTL Levels)
19	Loss of Input Power Alarm
20	Output Power Mute Input
21	Amplifier Disable Input
22	RS-232 IN (TTL Levels)

Power Requirements

Table 2: Electrical Power Requirements

Parameter	Minimum	Typical	Maximum
Positive Supply Voltage	+4.75V	+5.0V	+5.25V
Power Dissipation (Start of Life)			
Preamp		2.5W	-
Dual Pump Line		5W	-
Triple Pump Line		7W	-
Power Dissipation (End of Life)	-	-	
Preamp	-	-	12.5W
Dual Pump Line	-	-	23.5W
Triple Pump Line	-	-	35W
Ripple Noise	-	-	2%PP
Transient Pulse	+4.6V for 75ms.	-	+6.0V for 75ms.
Radiated Emissions	EN5022 class B		
Conducted Emissions	EN5022 class B		
Radiation Immunity	IEC801-3		
ESD	8kV to EN61000-4-2		

Digital Input Signals

Table 3: Digital inputs

Input	Description	Pin	Logic State	Action
ADI	Amplifier disable: - drive current to the pump lasers switched off.	21	TTL LOW TTL HIGH	Normal operation Pump laser(s) disabled
OPMI	Output power mute - output power set to a maximum 5mW	20	TTL LOW TTL HIGH	Normal operation Output set to 5mW

NOTE: THAT UNDER HIGH INPUT POWER CONDITIONS, CONSIDERABLE OUTPUT POWER MAY EXIST EVEN WHEN THE AMPLIFIER IS DISABLED OR MUTED. USE OF THESE INPUTS DOES NOT CONSTITUTE AN INTERLOCK AND THE AMPLIFIER MUST STILL BE CONSIDERED AS CLASS IIIb (3b).

Digital Output Signals

These signals are used as alarms for various system faults. Table 4 summarises the functions. These TTL compatible alarm outputs are all active high logic, i.e. TTL LOW = normal operation, TTL HIGH = alarm. Hysteresis is included on all alarms to prevent oscillation.

Table 4: Alarm Outputs

Alarm	Pin	Condition	Hysteresis
EDFA Temperature	7	This alarm is activated if the case temperature is >60°C or <-5°C	3°C
Loss of Output Power	8	This alarm is derived from an optical tap and PIN diode, and is activated if the output power falls below a user-specified value. The factory default value is set at 2dB from output power set point	0.5dB
Pump Bias	9	Set if any of the pumps are driven at greater than 95% of their end of life value	5mA
Pump Temperature	10	This alarm is activated if any of the pump submount temperatures are higher or lower than the set temperature by greater than 5°C	2°C
Loss of Input Power	19	This alarm is derived from an optical tap and PIN diode, and is activated if the input power falls below a user specified value. The factory default value is set at 6dB below the minimum operating point	0.3dB

Serial Communications Port

Management/status reporting is available through the serial port (TTL levels). If connecting to an RS232 interface, an interface converter (E.g. Maxim RS232ACPE) should be used (see Figure 1).

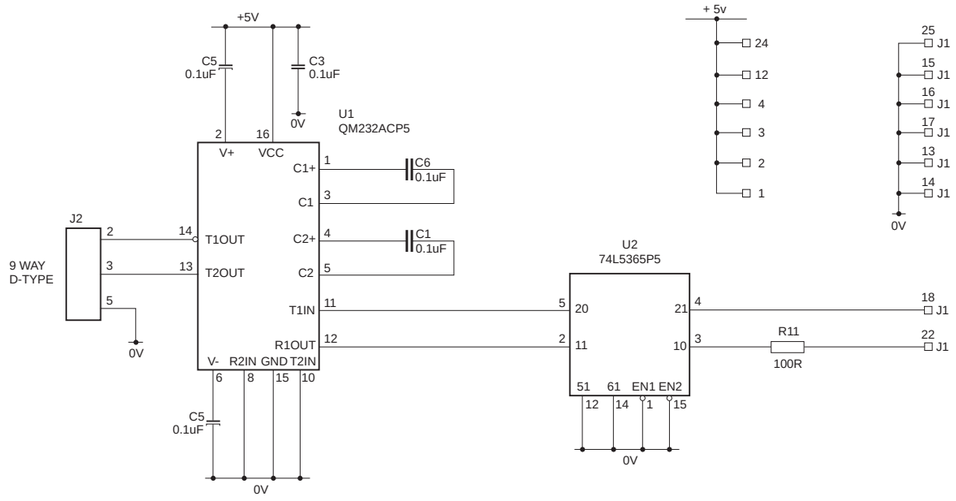


Figure 1: Suggested RS232 interface circuit

Alternatively, the Nortel Networks MGM EDFA interface board may be used. The interface board provides logic level conversion between the MGM EDFA serial data input/output pins (TTL Levels) and a PC serial port (RS-232 Levels).
Any terminal emulator program may be used. We recommend Microsoft® Terminal.

Port Configuration

The PC serial port settings should be configured as shown in Table 5.

Table 5: PC serial port configuration

Bits/second	9600
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None

MGM EDFA User Commands

All MGM Amplifiers are set up at the factory to operate as specified on the appropriate data sheet. The following commands can be used to interrogate the unit to find the various drive and monitoring conditions.

They also allow the user to change the configuration of the amplifier. In these cases, it must be appreciated that the amplifier may not operate as specified once these changes are made.

By reverting to the factory configuration, the amplifier will return to its original operating conditions.

Command Structure

The following section details the commands sent to the EDFA and the replies that would be received. All commands must be terminated by CR, LF set in the terminal properties menu. A prompt of the address of the unit is shown when a particular EDFA is ready to receive a command, e.g. **0001>**. A syntax error in command entry will give a reply of **???**

Note that when an EDFA is powered up it will be inactive (i.e. it will not respond to any commands received) until it receives its own address command. At this time it will then become active and reply to all subsequent commands. When a different address command is used to communicate with another unit the first EDFA will become inactive. Note that the terms active and inactive refer only to the communications operation and do not affect the optical function of the amplifier.

In the following command listing, the characters shown inside pointed brackets <> are mandatory. Where characters are shown in square brackets [ ] following a command, a choice of the listed options may be included.

Numbers within square brackets in the Amplifier Commands section refer to the amplifier stage being considered. For single amplifier designs all components are in the second stage.

Command Set

Password protected comments are identified by a (P) in the command title, and by a 'X' in the 'Pass' column in Table 6: Command set summary. Password protected commands are those which affect the operation of the amplifier, e.g. changing the gain or laser drive current.

The password is factory set to '1234' (it can be altered using the 'CP' command).

Establishing Communications

The following dialogue assumes communications have not been established and that there is only one EDFA connected to the PC serial port.

AD FFFF 1234 – Address any connected unit, password (optional) (FFFF is the universal address to which any connected EDFA will respond.)

The EDFA should respond with:-

XXXX>

Where XXXX is the hexadecimal EDFA address. Any of the commands shown in Table 6 may now be issued.

If the correct password is not sent, password protected commands will not be recognised and the EDFA will respond with:-

???
XXXX>

Addressing Multiple EDFAs

When 2 or more EDFAs are connected via a single serial port, each EDFA will need a different address using the Change address command (see CA in Address & Password Commands).

Address & Password Commands

The following list of commands and syntax examples assumes the unit address is 0001 and password is 1234.

AD <Unit Add.> [Password] **Address Unit**

AD 1 [1234]

Instructs unit with address 1 to become active and respond to protected commands. All modules are set to address 1 as the default. 1234 is the default password and allows use of commands which alter the EDFA operating mode.

AD FFFF

Instructs any connected unit to respond. This command may be used if the address of a particular EDFA is unknown
Reply is:
0001>

ADQ <Unit Add.> [Password] **Address Unit Quietly**

ADQ 1 [1234]

Same as the AD command, but unit does not echo characters.
Reply is:
0001>

CA <Serial No.> <Add.> **Change Address**

CA 12345678 0005

Change address of unit with serial number 12345678 to 0005.
Reply is:
OK
0005>

CP [Old] [New] [New] **Change Password (P)**

CP 1234 ABCD ABCD

Change the unit password from 1234 to ABCD. Password is a Hex value from 0001 to FFFE.
Reply is:
OK
0001>

Alarm Commands

IPW [1,2] [D,<value>]

Input Power Warning (Meteor only)
Provides low input power warning alarm without disabling the amplifier. Operates in conjunction with LO alarm.
Reply is:
OK
0001>

IPW [1,2]

Input Power Warning (Meteor only)
Reports the IPW level or if it is disabled
Reply is:
Disabled
0001>
Or in the form:
-20 dBm
0001>

LO [1,2] [D,<value>]

Sets or disables Loss Of Signal (LOS) input power alarm for the relevant stage (P)
Will disable amplifier when enabled in constant power mode only.
Reply is:
OK
0001>

LO [1,2]

Reports LOS value for the relevant stage
Reply is:
Disabled
0001>
or in the form:
-20 dBm
0001>

Amplifier Commands

AP

Amplifier Power
Reports input and output power levels.
Reply is in the form:
I/P:-31.2 dBm O/P:10 dBm
0001>

AS

Amplifier Status Request
Reports any problems with either of the amplifiers:

DISABLED	–	amplifier's output power is disabled.
SW	–	disable CMOS input is active.
PWR	–	amplifier cannot achieve its set output condition.
MUTE	–	MUTE CMOS input is active.
LOS	–	input power alarm is active.
IPW	–	input power warning is active (Meteor only)
TINT	–	unit's internal temperature is out of limits.
OK	–	the amplifier has no alarm warnings

Reply is:
STATUS: DISABLED, SW, PWR, MUTE, LOS, TINT, IPW, OK
0001>

EH

Erbium heater (Meteor only)
Reports whether an erbium heater is fitted or not.
Reply is:

FITTED	-	Heater is fitted
NOT FITTED	-	Heater is not fitted

0001>

IT

Internal temperature
Reports the internal temperature of the unit.
Reply is:
Tint : 30.6 C
0001>

SA [1,2] [O,G] [<Value>]

Set Amplifier (P)
Sets the operating condition for the relevant amplifier stage.
O defines output power control. Value field is power in dBm.
G defines gain control. Value field is gain in dB.
For single amplifier designs all components are in stage 2.

SA 2 G 23
Sets amplifier (stage 2) to constant gain of 23 dB.
SA 2 O 14
Sets amplifier (stage 2) to constant output power of +14 dBm
Reply is:
OK
0001>

SA [1,2]

Set Amplifier
Reports the operating condition for the relevant amplifier stage.
Reply is:
Stage 2: Mode[O,G][D] Req: 20.0 [dBm, dB]
0001>
The O or G indicate constant output power or gain mode. If the letter 'D' is present at least one of the lasers assigned to the stage is in constant drive current mode.

V

Version Inquiry
Asks for the version identification of the firmware currently loaded into program EEPROM and the version of the downloader software in EPROM.
Reply is:
Downloader V1.00
Micro V1.00
DSP V1.00
Serial No : AM12345.6
Gain Block No : AB45678.9

Pump Commands

FL [1,2,3]

Fit Laser
Replies 1, 2 or N (Y or N for Meteor) depending on which stage it is fitted to or whether it is absent. For single amplifier designs all components are in stage 2.
Reply is:
[1,2,N]
0001>

LP [1,2,3]

Laser Power

LP 1

Reports laser drive current and output power for laser 1.
Reply is:
P1 123.4 mA, 78.9 mW
0001>
Signifying the drive current for laser 1 is 123.4mA, and the output power is 78.9mW.

LS [1,2,3]

Laser Status

LS 1

Reports status of laser 1:
DISABLED – laser is disabled.
TLAS – laser's cooler temperature is out of limits.
IDRV – laser drive current is above its end of life value.
NOT FITTED – specified laser is not fitted.
DRV – laser is in constant forward current mode.
OK – no alarms.
Reply is:
LS 1: DISABLED TLAS IDRV NOT FITTED DRV OK
0001>

LT [1,2,3]

Laser Temperature

LT 1

Requests temperature of laser 1
Reply is:
T1: 20.5, 700mA
0001>
Signifying that the submount temperature of laser 1 is 20.5°C and the thermoelectric cooler drive current is 700mA.

MD [1,2,3] <N,<value>>

Mode Drive (P)
Sets the drive current for each laser or specifies whether the laser drive current is defined by the 'Set Amplifier' command, i.e. in constant output or constant gain mode. The 'Mode Drive' command overrides the drive requirements of the set amplifier command (SA) for the selected pump..

MD 1 80

Set laser 1 to 80 mA forward current.

MD 1 N

Set laser 1 control according to 'set amplifier' (SA) requirement.
Reply is:
OK
0001>

MD [1,2,3]

Mode Drive
Reports set drive current for laser, or whether drive current is under SA control.
Reply is one of the following three forms:

NOT FITTED – Laser not present in amp

123.4 mA – Constant drive mode, set to 123.4 mA

LASER 1: STAGE 1 – Not in constant drive mode, operating as part of stage 1, under SA control.

ST [1,2,3] [min] [set] [max]

Set Temperature (P)
Sets the thermal conditions for each laser.

ST 1 20 25 30

Sets the minimum submount temperature to 20 °C, operating point to 25 °C and the maximum temperature to 30 °C. The minimum and maximum values define the limits for temperature alarms.
Reply is:
OK
0001>

ST [1,2,3]

Set Temperature
Reports the temperature settings for each laser.

ST 1

Reports settings for laser 1.
Reply is:
L1 20:25:30
0001>
This signifies that for laser 1 the minimum temperature is 20°C, the set point is 25°C and the maximum temperature is 30°C. Note that on power-up, the lasers will not be supplied drive current until their submount temperatures are within the limits.

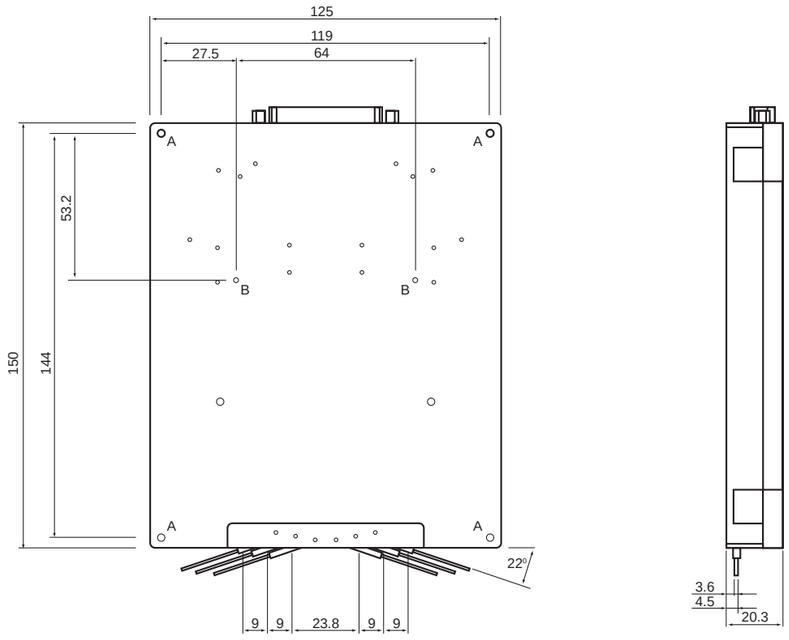
Table 6: Command set summary

	Arg1	Arg2	Arg3	Arg4	Read	Write	Pass	
AD	[<Unit address>]	<Password>				X		Address unit, optional password
ADQ	[<Unit address>]	<Password>				X		Quietly address unit
CA	[<Serial No>]	[<Address>]				X		Change unit address
AP					X			Displays amplifier powers
AS	[1,2]				X			Displays status of amplifier 1 or 2
CP	[Old Password]	[New Password]	[New Password]				X	Change password (Hex value 0001 to FFFE)
EH					X			Reports whether an erbium heater is fitted (Meteor only)
FL	[1,2,3]				X			Replies 1,2 or N depending on which stage laser is fitted to or whether it is absent
IPW	[1,2]	[D,<value>]				X		Sets or replies with input warning level (Meteor only)
IT					X			Reads internal temperature of unit
LO	[1,2]	[D,<value>]				X	X	Sets or disables LOS level for each stage
LO	[1,2]				X			Reports LOS value for stage
LP	[1,2,3]				X			Reads laser drive current & power
LS	[1,2,3]				X			Reports the status for each laser
LT	[1,2,3]				X			Reports the temperature for each laser
MD	[1,2,3]	<N,<value>>				X	X	Sets drive current for each laser, or returns control to Set Amplifier requirements
MD	[1,2,3]				X			Reads set drive current for laser, or reports which stage laser is fitted to
SA	[1,2]	[O,G]	[<Value>]			X	X	Sets the operating condition for each amplifier
SA	[1,2]				X			Reports the operating condition for each amplifier
ST	[1,2,3]	[min]	[set]	[max]		X	X	Sets the set temperature for each laser
ST	[1,2,3]				X			Reports the set temperature for each laser
V					X			Reports the version information

Mechanical

Figure 2 shows a schematic drawing of the complete module. The outer dimensions are shown in mm.

Figure 2: Device Dimensions



HOLE	DESCRIPTION	QTY:
A	M3x0.5 x 13 DEEP	4
B	M3x0.5 x 8 DEEP	2

Table 7: Mechanical Dimensions

Parameter	Specification Limits			Units
	Min	Typ	Max	
Module Length			150	mm
Module Width			125	mm
Module Height			20.3	mm
Optical Pigtail Length	950	1000	1050	mm